
एल्युमीनियम क्लोराइड, जलरहित,
तकनीकी — विशिष्टि

(पहला पुनरीक्षण)

Aluminium Chloride, Anhydrous,
Technical — Specification

(First Revision)

ICS 77.150.10

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Inorganic Chemicals Sectional Committee had been approved by the Chemical Division Council.

The standard was first published in 1972. In the present revision, requirements for two types of aluminium chloride based on their physical states have been stipulated. Accordingly, all requirements have been modified and new requirements for total aluminium, free aluminium and solubility have been included. The test methods have also been modified.

Aluminium chloride, anhydrous, technical finds extensive use in Friedel-Crafts reaction specially in the manufacture of various pharmaceuticals and dyestuffs, in cracking of petroleum; in the manufacture of rubber, and lubricants; in preserving wood, in refining of crude oil, dyeing of fabrics, in manufacture of parchment paper, detergents and ethylbenzene, polymerization and isomerization reaction of hydrocarbons etc.

The composition of committee responsible for the formulation of this standard is given at Annex H.

For the purpose of deciding whether a particular-requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ALUMINIUM CHLORIDE, ANHYDROUS, TECHNICAL — SPECIFICATION

(First Revision)

1 SCOPE

This Indian Standard prescribes the requirements, method of sampling and test for aluminium chloride, anhydrous, technical.

2 REFERENCES

The Indian Standards listed below contain provisions which through reference in this text, constitute provisions of this Indian Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Indian Standard are encouraged to investigate the possibility of applying the most recent editions of the Indian Standards:

<i>IS No.</i>	<i>Title</i>
1070 : 1992	Reagent grade water (third revision)
3025	Methods of sampling and test (physical and chemical) for water and waste water
(Part 2) : 2004/ISO 11885 : 1996	Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
(Part 53) : 2003	Iron (first revision)
4905 : 2015/ISO	Random sampling and randomization procedures
24153 : 2009	(first revision)

3 REQUIREMENTS

3.1 Description

The material shall be in the form of Powder or Granule.

3.1.1 For Powder

Aluminium chloride, anhydrous, technical shall be grey to white or yellow with strong hydrochloric acid odour. The particle size of material shall be as agreed to between the purchaser and the supplier.

3.1.2 For Granule

Aluminum chloride, anhydrous, technical shall be grey to white or yellow with strong hydrochloric acid

odour. The particle size of material shall be as agreed to between the purchaser and the supplier.

3.2 The material shall also comply with the requirements given in Table 1 when tested in accordance with the methods prescribed in col 5 of Table 1.

**Table 1 Requirements For Aluminium Chloride,
Anhydrous, Technical**
(Clause 3.2)

SI No.	Characteristics	Requirement		Method of Test Ref. to Annex
		Powder	Granule	
(1)	(2)	(3)	(4)	(5)
i)	Insoluble matter, percent by mass, <i>Max</i>	0.1	0.1	A
ii)	Assay as AlCl_3 , percent by mass, <i>Min</i>	98.5	99.0	B
iii)	Total Aluminium as Al, percent by mass, <i>Min</i>	19.9	20.0	C
iv)	Free Aluminium as Al, percent by mass, <i>Max</i>	0.015	0.015	D
v)	Iron as Fe, percent by mass, <i>Max</i>	0.03	0.02	E
vi)	Solubility			F
	a) Ether	-----To pass the test---		
	b) Nitrobenzene	-----To pass the test---		

4 PACKING AND MARKING

4.1 Packing

Anhydrous aluminum chloride shall be packed in HDPE bags with inner PVC liner or moisture-proof steel drums provided with an inner PVC liner. The liners shall be either sealed or knotted separately, the knot secured by suitable plastic thread. The container will be provided with a close fitting cover with rubber gasket and tightening ring to securely close it. The material shall be packed in Jumbo bags with inner PVC liners or as agreed to between the purchaser and the suppliers. Anhydrous aluminum chloride is highly reactive with moisture when exposed to atmosphere emitting toxic acids fumes. Thus, packing must be airtight.

4.1.1 For smaller packing's the material shall be packed in amber coloured glass bottles provided with well-fitting ground glass stoppers or in airtight fluorinated high density polyethylene bottles.

4.2 Marking

The containers shall be securely closed and marked legibly and indelibly with the following information:

- a) Name of the material (powder or granule);
- b) Name of the manufacturer and trade-mark, if any;
- c) Mass of the material in package;
- d) Lot No./Batch No., and
- e) Date of packing/manufacturing.

4.2.1 The container shall also be prominently marked with the following information to notice clearly.

“Corrosive solid irritating to skin, wash spillage with ample water. On contact with skin, wash immediately with plenty of water. Wear suitable gloves and eyes protection gears, while handling the material. Remove

leaking package/drums to well ventilated place, keep away from fire and water, store at ambient temperature.”

4.2.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

5 SAMPLING

Representative samples of the material shall be drawn and their conformity to this standard shall be determined in accordance with the method prescribed in Annex G.

6 QUALITY OF REAGENTS

6.1 Unless specified otherwise pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — ‘Pure chemicals’ shall mean chemicals that do not contain impurities which affect the results of analysis.

ANNEX A

[Table 1, Sl. No (i)]

DETERMINATION OF INSOLUBLE MATTER

A-1 APPARATUS

A-1.1 Weighing Bottle

A-1.2 600 ml Glass Beaker

A-1.3 Watch Glass

A-1.4 Weighing Balance — Range 200 g (*Max*), Least Count 1 mg.

A-1.5 Sintered Glass Crucible — G No.4 along with facility for filtration under suction.

A-2 PROCEDURE

Weigh accurately about 2 g of the material by weighing in a dry weighing bottle and transfer it quickly into a 600 ml dry glass beaker and cover with a watch glass.

Add immediately and cautiously 200 ml of distilled water after lifting the watch glass. Allow to stand for 15 to 20 minutes with occasional stirring to allow for complete dissolution. Filter through a weighed sintered glass crucible (G No.4) under suction and wash with distilled water till the filtrate is free from acid. Dry the crucible at 105 ± 2 °C to a constant mass.

NOTE — It is advisable to use plastic ware/spatula for transfer of product to weighing bottle.

A-3 CALCULATION

$$\text{Insoluble matter, percent by mass} = 100 \times \frac{m}{M}$$

where

m = mass in g, of the residue, and

M = mass in g, of the material taken for the test.

ANNEX B

(Table 1, Sl. No (ii))

DETERMINATION OF ALUMINIUM CHLORIDE CONTENT

B-1 APPARATUS

B-1.1 Silica Crucible — 50 ml capacity.

B-1.2 Asbestos Sheet — A thick asbestos sheet (15 × 15 cm approximately) with a hole in the centre of such dimensions that the silica crucible just fits at the rim.

B-1.3 Stoppered Weighing Bottle — 60 mm long and 30 mm diameter.

B-2 PROCEDURE

Take 10 to 11 g of anhydrous aluminum chloride in the weighing bottle and stopper immediately, so as not to expose the material to the atmosphere. Weigh accurately (W_1) and transfer material quickly to the accurately weighed silica crucible (W_3), which has been placed in the asbestos sheet on the tripod stand inside a fuming chamber and immediately stopper the weighing bottle and transfer it to a desiccator. Later, weigh the empty weighing bottle accurately (W_2). Immediately

start heating the crucible with a regulated burner (at a temperature of approximately 250 °C) so that the entire crucible is heated uniformly and continue the ignition till all aluminum chloride is sublimed as indicated by absence of fumes. Continue calcining for about 30 min, Cool in a desiccator over calcium chloride and weigh accurately the cooled crucible (W_4).

B-3 CALCULATION

Aluminium Chloride content.

$$\text{Percent by mass} = \frac{(W_1 - W_2) - (W_4 - W_3)}{W_1 - W_2} \times 100$$

where

W_1 = mass in g, of the weighing bottle with sample;

W_2 = mass in g, of the weighing bottle after transferring the sample;

W_3 = mass in g, of the crucible; and

W_4 = mass in g, of the crucible with residue after sublimation.

ANNEX C

[Table 1, Sl. No (iii)]

DETERMINATION OF ALUMINUM CONTENT (TITRATION METHOD)

C-1 PRINCIPLE

Total Aluminum in sample solution is convert to Al^{3+} ions by addition of dilute nitric acid and heating, followed by complexation of Al^{3+} with an excess of EDTA solution. Excess EDTA is titrated with a standard volumetric solution of zinc using xylenol orange as indicator.

C-2 REAGENTS

C-2.1 Nitric Acid (1 : 12)

C-2.2 Standard EDTA Solution — M/50-dissolve 7.4448 g ethylene diamine tetra acetic acid disodium salt dihydrate in 1 000 ml of distilled water.

C-2.3 Sodium Acetate Buffer Solution — Dissolve 272 g of sodium acetate trihydrate in water and dilute to 1 litre.

C-2.4. Xylenol Orange Indicator — Grind 1.0 g of xylenol orange with 99 g of potassium nitrate in a mortar until a homogeneous material is obtained and store in a closed container.

C-2.5 Standard Zinc Solution — M/50-Weigh accurately about 1.308 g AR zinc metal pellets/granules and transfer to a 250 ml beaker, add small amount of water and 6-7 ml of hydrochloric acid AR and cover with watch glass. Heat to dissolve zinc, evaporate on a water bath nearly to dryness. Dissolve the residue in water, transfer the contents quantitatively to a 1 000 ml volumetric flask and make up to the mark.

$$\text{Molarity of zinc solution, } M = \frac{m}{65.38}$$

where

m = mass of zinc metal taken for preparation of solution.

C-3 PROCEDURE

C- 3.1 Sample Titration

Weight accurately about 1.5 gm of sample, transfer in a 500 ml volumetric flask and add about 10-15 ml of chilled distilled water and stopper the flask. When

fumes generation stops, shake vigorously to dissolve, when all the fumes are cleared and dissolved, then open the flask and make up to mark with distilled water. Label it as solution B.

Pipette out accurately 20 ml of solution B to a 250 ml conical flask, add 2 ml of nitric acid, (*see* C-2.1), the pH value shall be between 1 to 2, boil for 1 min, allow to cool and add 20 ml of N/50 EDTA solution exactly by pipette.

Adjust to pH 3 with nitric acid or 10 percent sodium hydroxide solution using pH meter or by thymol blue pH test paper. Boil for about 2 min.

Cool and add approximately 10 ml sodium acetate buffer solution (pH of mixture should be between 5 and 6). Add 30 – 50 mg of one percent (w/w) xylenol orange indicator (*see* C-2.4) in the solution and stir.

Titrate the solution with N/50 zinc solution, making the end point the time when the colour of the solution turns from bright pale yellow colour to pale red.

C-3.2 Blank Titration

In parallel, pipette out 20 ml N/50 EDTA, add 2 ml of nitric acid (1 : 12) solution to a 250 ml conical flask, add about 20 ml distilled water, 10 ml of sodium acetate buffer solution (for maintaining pH between 5 and 6), add 30-50 mg of xylenol orange indicator and proceed the titration of test blank as described in above for test sample.

C-4 CALCULATION

Total aluminum content, percent by mass =

$$\frac{67.45 \times M (V_1 - V_2)}{W}$$

where

M = Molarity of standard zinc solution;

V_1 = Titre of standard zinc solution used in blank determination in ml;

V_2 = Titre of standard zinc solution used for sample solution, in ml; and

W = Sample taken for test, in g.

ANNEX D

[Table 1, Sl. No (iv)]

DETERMINATION OF FREE ALUMINUM CONTENT

D-1 APPARATUS

D-1.1 Ice Bath — To maintain the temperature 5-20 °C

D-2 REAGENTS

D-2.1 Ferric Chloride Solution — 10 percent *m/v* (prepared with 1 : 1 HCl).

D-2.2 Phosphoric Acid (Orthophosphoric Acid) — 85 percent.

D-2.3 Sodium Diphenylamine Sulphonate Indicator

D-2.4 Potassium Dichromate Solution — 0.05 N.

D-3 PROCEDURE

Pipette out 50 ml ferric chloride solution into a 500 ml beaker and add 100 ml distilled water. Place the beaker in ice bath to reduce the temperature below 20 °C. Weigh accurately about 5 grams of the sample and pour the sample, a small quantity at a time into the cold ferric chloride solution. Stir vigorously during the period of addition and reaction, using a thermometer as a stirring rod and control the temperature around 10 °C.

After the reaction is complete, add 100 ml of cold distilled water to bring the volume up to 250 ml. Add 5 ml of 85 percent phosphoric acid and two drop of sodium diphenylamine sulphonate indicator and titrate with 0.05 N potassium dichromate Solution. Colour changes from yellow to greenish and finally to blue violet.

Determine the blank on the 50 ml aliquot of the ferric chloride solution by carrying entire procedure without the addition of the sample.

D-4 CALCULATION

Free Aluminum content as Al percent by mass =

$$\frac{2.7(V_1 - V_2) \times N}{M}$$

where

V_2 = Titre of standard potassium dichromate solution used in blank Determination, in ml;

V_1 = Titre of standard potassium dichromate solution used for sample solution, in ml;

N = Normality of standard potassium dichromate solution; and

M = Mass in g, of the sample taken.

ANNEX E

[Table 1, Sl. No (v)]

DETERMINATION OF IRON

E-1 PRINCIPLE

Iron (III) reacts with Thiocyanate to give a series of internally red coloured compounds, which remains in true solution. Strong acids (hydrochloric acid) should be present to compress the hydrolysis. Alternatively any visual Spectrophotometer, suitable for measurement at a wave length of about 480 nm may be used.

E-2 APPARATUS

E-2.1 Nessler Cylinders — 100 ml capacity.

E-3 REAGENTS

E-3.1 Dilute Hydrochloric Acid — Approx. 4 N.

E-3.2 Ammonium Persulphate (Solid)

E-3.3 Ammonium Thiocyanate Solution — Dissolve 10 g of ammonium thiocyanate in 100 ml distilled water.

E-3.4 Standard Iron Solution A — Dissolve 0.702 g of ferrous ammonium sulphate $[\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}]$ in water in a 1 000 ml volumetric flask, add 4 ml of concentrated sulphuric acid and make up to the mark with water. One milliliter of this solution contains 0.1 mg of Iron (as Fe).

E-3.5 Standard Iron Solution B — Take 100 ml of standard iron solution A (*see E-3.4*), add dilute potassium permanganate solution (0.2 percent, *m/v*) drop wise with constant stirring, until a slight pink colour persists after stirring and dilute to the mark in a 1 000 ml volumetric flask. This dilute solution should be prepared afresh. One milliliter of this solution contains 0.01 mg of iron (as Fe).

E-4 PROCEDURE

Dissolve 1g of the accurately weighed material in 10 ml of water contained in a Nessler cylinder. Add 2 ml of dilute hydrochloric acid and dilute to about 45 ml. Add about 30 mg of ammonium persulphate and 3 ml of ammonium thiocyanate solution. Dilute to 100 ml mark and mix. Carry out a control test in another Nessler cylinder using distilled water. Using a micro pipette, add standard iron solution B to the blank and shake well, until the colour matches to that of a sample.

E-5 CALCULATION

Iron content as Fe, percent by mass = $\frac{V \times 0.001}{M}$

where

V = Volume of standard iron solution (B), in ml;
and

M = Mass of sample taken for the test, in g.

E-6 ALTERNATE TEST METHOD FOR DETERMINATION OF IRON**E-6.1 General**

Trivalent iron is reduced by means of hydroxyl-ammonium chloride and a bivalent iron-2, 2'-bipyridyl complex at pH 3.1, at a temperature of 75 °C is formed. Photometric measurement of the coloured complex is done at a wavelength of about 520 nm.

E-6.2 Apparatus

E-6.2.1 pH Meter — Fitted with glass electrode.

E-6.2.2 Spectrophotometer — Or photoelectric colorimeter provided with a 1 cm cell.

E-6.3 Reagents

E-6.3.1 Concentrated Hydrochloric Acid — See IS 265.

E-6.3.2 2,2'-Bipyridyl Solution — Dissolve 0.50 g of 2, 2'-bipyridyl in 10 ml of concentrated hydrochloric acid and dilute to 100 ml with water.

E-6.3.3 Ammonium Acetate Solution — Dissolve 300 g of ammonium acetate in water and make the volume to 1 000 ml.

E-6.3.4 Hydroxylammonium Chloride — Dissolve 10 g of hydroxyl-ammonium chloride ($\text{NH}_2\text{OH} \cdot \text{HCl}$) in water and dilute to 100 ml.

E-6.3.5 Standard Iron Solution — Dissolve 0.702 g of ferrous ammonium sulphate [$\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$] in 20 ml of 10 percent sulphuric acid and dilute with water to exactly 500 ml. Further dilute 100 ml of this solution to 1 000 ml. One millilitre of the diluted solution is equivalent to 0.02 mg of iron (as Fe).

E-6.4 Procedure**E-6.4.1 For Technical Grade**

E-6.4.1.1 Preparation of sample solution — Weigh 50 g of the material to the nearest 0.01 g in a small glass beaker. Transfer quantitatively to a 500-ml volumetric flask and make up to the mark with carbon dioxide-free water. Mix and use the sample solution for tests. Pipette out 5 ml of the sample solution in a 100-ml volumetric flask and dilute to the mark. Shake the contents. This diluted solution shall be called the diluted sample solution.

E-6.4.1.2 Blank test — At the same time as the analysis, carry out a blank test using the procedure described in **E-6.4.1.4** and the same quantities of all reagents.

E-6.4.1.3 Preparation of Calibration Curve — Proceed as given below:

- a) *Preliminary Check of pH* — Place 5 ml of concentrated hydrochloric acid in a beaker of suitable capacity (100 ml for example), dilute to approximately 50 ml, add 1 ml of hydroxylammonium chloride solution and 5 ml of 2,2'-bipyridyl solution. Allow to stand for about ten minutes and using the pH meter, adjust the pH of the solution to 3.1 by addition of ammonium acetate solution. Note the quantity of ammonium acetate added for the pH adjustment and then discard the solution.
- b) *Preparation of Standard Solutions* — Into each of a series of five beakers of suitable capacity (100 ml, for example), place the quantities of standard iron solution indicated below:

Standard Iron Solution	Corresponding to Iron (Fe)
ml	µg
0	0
5.0	100
10.0	200
15.0	300
25.0	500

Then add 5 ml of concentrated hydrochloric acid and dilute to approximately 50 ml.

- c) *Colour Development* — To each of the above-mentioned solutions, add 1 ml of hydroxylammonium chloride solution and 5 ml of 2, 2'-bipyridyl solution. Allow to stand for about ten minutes, then add the quantity of ammonium acetate solution determined following the procedure of **E-6.4.1.3 (a)**. Heat the solutions on a water-bath at approximately 75 °C for about fifteen minutes and then cool to room temperature. Transfer to 100 ml one-mark volumetric flasks, dilute to the mark and mix thoroughly.

- d) *Photometric Measurement* — Measure the optical density of each solution using either the spectrophotometer at a wavelength of about 520 nm or the photoelectric colorimeter with a suitable filter, adjusting the instrument to zero optical density using as reference the compensation solution.
- e) *Preparation of calibration chart* — Prepare a calibration chart having the iron (Fe) content in micrograms per 100 ml of the standard solution as abscissa and the corresponding values of optical density as ordinate.

E-6.4.1.4 Determination — Pipette out 10 ml of the diluted sample solution into a beaker of suitable capacity (100 ml, for example) and dilute to approximately 50 ml. Add 1 ml of hydroxylammonium chloride solution and 5 ml of 2, 2'-bipyridyl solution. Allow to stand for about ten minutes, then using the pH meter adjust the pH of the solution to 3.1 by addition of ammonium acetate solution. Heat the solution on a water-bath to approximately 75 °C for about fifteen minutes and cool to room temperature. Transfer quantitatively the solution to a 100 ml one-mark volumetric flask, dilute

to the mark and mix thoroughly. Measure the optical density of the solution adjusting the instrument to zero optical density with the blank test solution and following the procedure described in E-6.4.1.3 (d).

E-6.4.1.5 Calculation — By reference to the calibration chart, read the iron content corresponding to the photometric measurement of the sample and calculate, as given below:

$$\text{Iron (as Fe), percent by mass} = \frac{A \times 100 \times 100}{E}$$

where

A = mass in g, of iron determined in the sample solution, and

E = mass in g, of the sample taken for the test in E-6.4.1.1

E-6.5 Iron content may also be determined by ICP-AES as prescribed in IS 3025 (Part 2).

E-7 REFEREE METHOD

Determine Iron content by Atomic Absorption Spectrophotometer method as given in IS 3025 (Part 53).

ANNEX F

[Table 1, Sl. No (vi)]

SOLUBILITY TEST

F-1 PROCEDURE

F-1.1 Dissolve 5 gm of AlCl_3 sample in 50 ml of ether in a conical flask with moderate shaking. Sample complies the test if it is dissolved completely producing pale brown colour clear solution.

F-1.2 Dissolve 5 gm of AlCl_3 sample in 75 ml of nitrobenzene in a conical flask with moderate shaking. Sample complies the test if it dissolves completely to give clear solution.

ANNEX G

(Clause 5.1)

SAMPLING OF ALUMINIUM CHLORIDE

G-1 GENERAL REQUIREMENTS OF SAMPLING

G-1.1 In drawing samples, the following precautions and directions shall be observed.

G-1.2 Precautions shall be taken to protect the samples, the sampling instrument and the containers for samples from adventitious contamination.

G-1.3 The sampled material shall be placed in suitable, dry, clean container.

G-1.4 Each sample container shall be sealed air-tight after filling and marked with full details of sampling.

G-1.5 Samples shall be taken from different parts of the containers using suitable sampling instrument.

G-2 SCALE OF SAMPLING

G-2.1 All the containers in a consignment of aluminum chloride, anhydrous, technical, taken from a single batch of manufacture shall constitute a lot.

G-2.2 Samples shall be tested for each lot for ascertaining the conformity of the material to the requirements of the specification.

G-2.3 The number (n) of containers to be selected from the lot shall depend upon the size of the lot (N) and shall be in accordance with Col.1 and 2 of Table 2.

Table 2 Number of Containers to be Selected
(Clause G-2.3)

Sl No.	Lot Size	No. of Containers to be Selected
	N	n
(1)	(2)	(3)
i)	Up to 25	3
ii)	26 to 50	4
iii)	51 to 100	5
iv)	101 and above	7

G-2.4 These containers shall be selected at random from the lot. For random selection procedures, guidance may be sought from IS 4905.

G-3 PREPARATION OF TEST SAMPLES

G-3.1 From each of the selected containers 100 g of aluminum chloride shall be withdrawn with the help of

a sampling instrument. Out of the portions so collected equal quantity of the material shall be taken out and mixed together to form a composite sample of about 150 g. The remaining portions corresponding to each of the selected containers shall be transferred to separate sample bottles and these samples bottles containing aluminum chloride shall be termed as individual samples.

G-3.2 Tests for aluminum chloride content shall be conducted on individual samples. Tests for all the other characteristics shall be made on the composite sample.

G-4 CRITERIA FOR CONFORMITY OF THE LOT

G-4.1 Aluminum Chloride Content — Form the individual test results on assay the mean \bar{X} and the range (R) of the test results shall be calculated (range being defined as the differences between the maximum and minimum values). The values of the expression $(\bar{X} - 0.6 R)$ shall be greater than or equal to the corresponding value given in col 3 and 4 of Table 1.

G-4.2 For Other Characteristics — The test results for other characteristics tested on the composite sample shall satisfy the relevant requirements.

G-4.3 A lot shall be declared as conforming to the requirements of this specification if **G-4.1** and

G-4.2 are both complied with.

ANNEX H

(Foreword)

COMMITTEE COMPOSITION

Inorganic Chemicals Sectional Committee, CHD 01

<i>Organization</i>	<i>Representative(s)</i>
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Delhi Jal Board	SHRI ASHUTOSH KAUSHIK
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Member Secretary

SAGAR SINGH
SCIENTIST 'C' (CHD), BIS

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This Indian Standard has been developed from Doc No.: CHD 01 (12532).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi